CASE REPORT

Extracorporeal membrane oxygenation as a bridge to pulmonary transplantation in Brazil: Are we ready to embark upon this new age?

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INTRODUCTION

Currently, there are few centers able to perform pulmonary transplantation in Brazil.[1] The number of patients in need of this procedure and their disease severity has increased in recent years; however, the reduced number of lung donors has resulted in a high mortality rate for patients on the waiting list.[2] Some of these patients with exacerbations of severe chronic pulmonary disease can be temporarily supported by extracorporeal membrane oxygenation systems, prolonging life until a donor lung is available for transplantation.[3] Those patients who are mechanically supported should receive the donated lungs with priority and should be shifted forward on the waiting list.[4] In Brazil, there are no extracorporeal membrane oxygenation centers and, consequently, a prioritization system for patients awaiting lung transplantation using extracorporeal membrane oxygenation does not exist.[5] This report describes our experience with an exacerbated severe hypoxemic patient awaiting lung transplantation and using extracorporeal membrane oxygenation in a tertiary center in Brazil.

CASE REPORT

An eighteen-year-old woman was admitted to the respiratory intensive care unit of the Hospital das Clínicas de São Paulo, Brazil, with the diagnosis of pneumonia. The chest X-ray is shown in Figure 1. She had a previous history of advanced cystic fibrosis, was awaiting lung transplantation and was in the fifth position on the São Paulo State waiting list. During the first day of her respiratory intensive care unit stay, her status deteriorated, she was intubated, and mechanical ventilation was started. In spite of the ventilatory support, she developed severe hypoxemic and hypercapnic respiratory failure (Table 1), with no signs of hemodynamic compromise. Femoro-femoral venous-venous extracorporeal membrane oxygenation support was then initiated after ultrasound-guided placement of the cannulas. Arterial blood gases improved, promoting a comfortable spontaneous breathing pattern during mechanical ventilation. Trivial anticoagulation with heparin was started and titrated to a ratio of activated thromboplastin time of 1.5–2.3. The clinical characteristics during the patient's respiratory intensive care unit stay are shown in Table 1. The patient was maintained awake with a Richmond Agitation Sedation Scale score ranging from -1 to 0.

The patient's condition gradually improved, and daily weaning from extracorporeal membrane oxygenation was performed by zeroing the sweeper flow of the oxygenation membrane. Our criteria for extracorporeal membrane oxygenation removal are as follows: (1) the patient is awake and comfortable throughout the test and (2) $PaO_2 \geq 55$ mmHg and $PaCO_2 \leq 60$ mmHg (or $pH \geq 7.30$ in patients with chronic hypercapnia) after one hour of ventilation with PEEP ≤ 10 cm H_2O, $FIO_2 \leq 0.6$ and a tidal volume ≤ 6 mL/kg (or a driving pressure ≤ 12 cm H_2O). We abort the test when (1) the peripheral oxygen saturation is less than 85%, (2) the patient presents clinical signs of dyspnea, or (3) the

Figure 1 - Chest X-ray before the installation of ECMO.

Table 1 - Clinical data and arterial blood gases.

Data	Pre-ECMO	Day 1	Day 2	Day 3	Day 4	Day 18
Mechanical ventilation						
Ventilatory mode	VCV ‖	PSV ‖	PSV ‖	PSV ‖	PSV ‖	PSV ‖
Peak pressure (min – max) - cm H_2O	28 - 28	28 - 33	28 - 33	28 - 28	26 - 28	24 - 24
PEEP (min – max) - cm H_2O £	20 – 20	20 – 25	20 - 25	20 - 20	18 - 20	10 – 10
FIO_2 (min – max) ¥	0.6 – 0.7	0.7 – 0.7	0.6 – 0.7	0.6 – 0.6	0.6 – 0.6	0.6 – 0.6
Respiratory rate (min – max) - breaths/min	22 - 30	25 - 36	18 - 34	22 - 39	24 – 36	22 - 38
ECMO €						
Blood flow (min – max) - L/min	6.0 – 6.5	6.0 – 6.0	5.5 – 6.0	5.0 – 5.5	5.0 – 5.0	5.0 – 5.0
Sweeper flow (min – max) - L/min	6.0 – 10.0	6.0 – 6.0	4.0 – 6.0	2.5 – 4.0	2.5 – 2.5	2.5 – 2.5
FIO_2	1.0	1.0	1.0	1.0	1.0	1.0
Routine blood gas						
PaO_2 - mm Hg	42	50	62	74	55	81
$PaCO_2$ - mm Hg	118	51	38	53	51	51
SBE - mEq/L *	1.8	6.1	-1.0	0.9	-0.8	2.1
pH	7.10	7.41	7.43	7.33	7.32	7.36
Patient data						
RASS (min – max) #	-1 - 0	0 - 0	0 – 0	0 – 0	0 – 0	-5 - 0
Lung injury score ¶	4.00	4.00	4.00	3.75	3.75	3.00
Total SOFA score §	10	9	6	4	4	4
Respiratory SOFA	4	4	4	4	4	4
Cardiovascular SOFA	3	3	0	0	0	0
Hematological SOFA	1	1	1	0	0	0
Hepatic SOFA	1	0	0	0	0	0
Neurological SOFA	0	0	0	0	0	0
Renal SOFA	1	1	1	0	0	0

*SBE denotes standard base excess.
RASS denotes Richmond agitation sedation score.
§SOFA denotes sequential organ failure assessment. This is a score to diagnose and quantify organ failure, which ranges from 0 to 24.
¶ The lung injury score is Murray's score, which quantifies the severity of lung injury based on the respiratory compliance, PEEP, number of quadrants of chest X-ray infiltrated and PaO_2/FIO_2 ratio.
| VCV denotes volume-controlled ventilation.
‖ PSV denotes pressure-support ventilation.
£ PEEP denotes positive end-expiratory pressure.
¥ FiO_2 denotes inspiratory fraction of oxygen.
€ ECMO denotes extracorporeal membrane oxygenation.

staff deems such an action to be necessary. The patient remained on extracorporeal membrane oxygenation support for 18 days with no adverse events, but she never tolerated more than five minutes of the weaning test. After 18 days of extracorporeal membrane oxygenation support, the patient died.

DISCUSSION

In the case presented, before the initiation of extracorporeal membrane oxygenation support, we promoted an extensive discussion between the respiratory intensive care unit and transplantation teams in order to define the focus of care. The background of the discussion was the absence, in Brazil, of prioritization criteria for patients on the waiting list for lung transplantation who require extracorporeal membrane oxygenation support when weaning from extracorporeal membrane oxygenation is considered difficult or impossible. The final decision was to start extracorporeal membrane oxygenation support and to file a special request to the Ministry of Health, asking to prioritize the patient on the lung transplantation waiting list. Our expectation was that with full intensive care support and antibiotics, the patient would gradually improve toward a clinical condition that was sufficient to allow lung transplantation. In the meantime, our request was analyzed by the Ministry of Health.

The extrapulmonary organ dysfunctions of the patient quickly resolved; from a clinical standpoint, she was able to undergo lung transplantation from the third day of her stay in the respiratory intensive care unit. Despite her clinical improvement, she remained completely dependent on extracorporeal membrane oxygenation support (i.e., the use of extracorporeal membrane oxygenation as a bridge to lung transplantation). On the 17th day of her stay in the respiratory intensive care unit, the Ministry of Health approved prioritization of the patient on the lung transplantation list on an exceptional basis due to the circumstances. During this period, no transplant had been performed from donors with the same blood type as the patient. Unfortunately, the patient died on the 18th day of her stay in the respiratory intensive care unit.

In summary, we believe that our experience with this case should motivate revision of the current legislation regulating lung transplants in Brazil, as well as the procurement, conservation, and reconditioning of organ systems. The scenario in which patients with exacerbations of chronic severe pulmonary diseases will become dependent on the support of extracorporeal devices will become frequent. Should the clinical conditions allow, prioritization on the waiting list for lung transplantation for these patients should be carefully considered.

APPENDIX

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